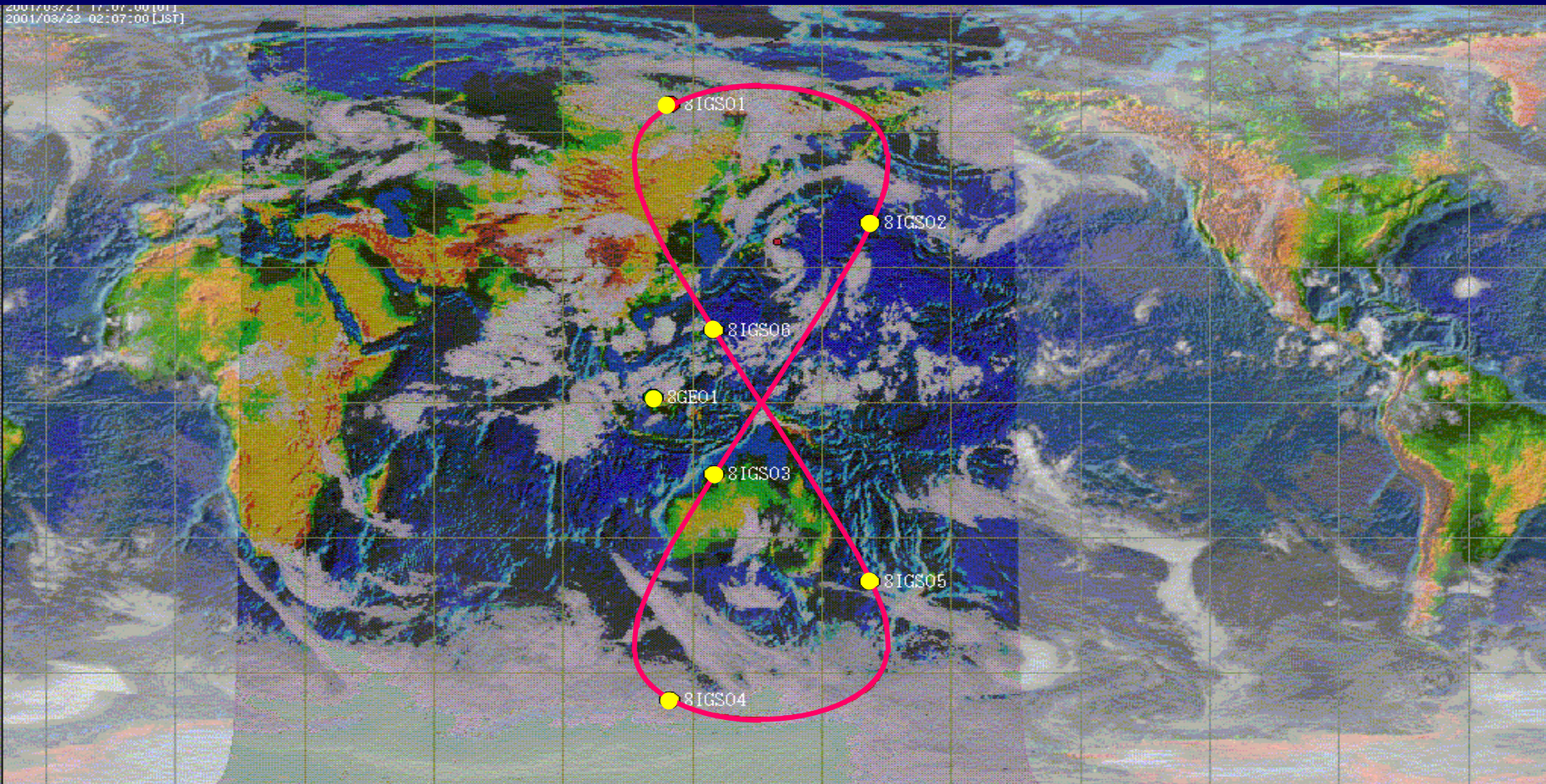
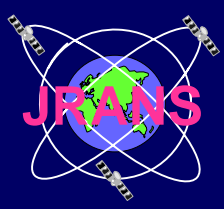


# JRANS Concept

CGSIC - 39th Meeting in Springfield, Virginia  
April 18, 2002

ITOCHU Corporation  
NEC TOSHIBA Space Systems, Ltd.



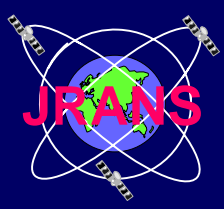


# Disclaimer

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2

**The proposed JRANS concept is ITOCHU and NEC / TOSHIBA proprietary, and does not represent the policies or positions of the Government of Japan or the US Government.**

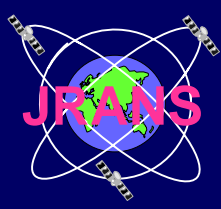


## **Part 1**

# **Marketing Session for JRANS Presentation**

**Duke TAKAHASHI, JRANS Program Manager**  
**Aerospace, Electronics & Multimedia Company**  
**ITOCHU Corporation**



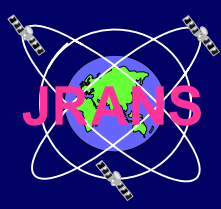


# JRANS Initiatives

4

## Japanese Regional Advanced Navigation Satellite

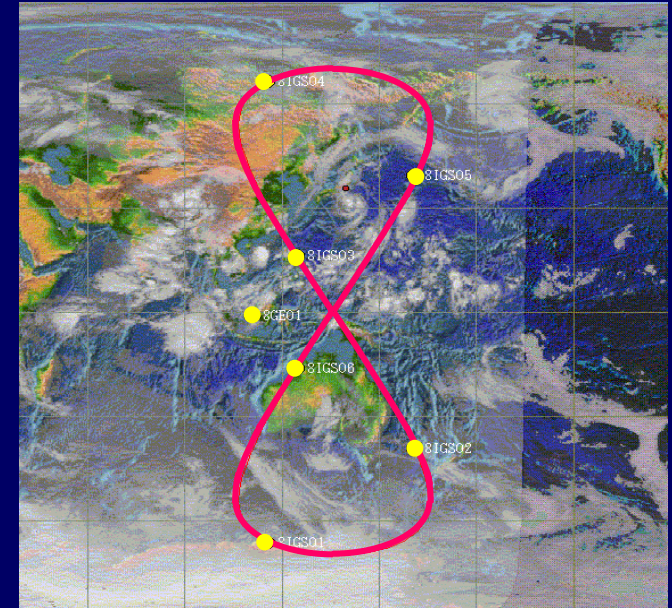
- ✓ In Sep '00, ITOCHU developed JRANS concept and started making the unsolicited proposal to the GOJ.
- ✓ In Dec '00, ITOCHU invited NEC and TOSHIBA, two major satellite builders in Japan, to JRANS promotion team.  
In Apr '01, NEC and TOSHIBA jointly established NEC TOSHIBA Space Systems, Ltd. ( “NEC / TOSHIBA” ) and merged their respective space business into the joint venture.
- ✓ NEC / TOSHIBA provides necessary technical support to ITOCHU.

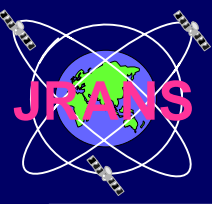


# JRANS Concept

5

- ✓ **Regional Navigation Satellite System** as a complementary system to GPS
- ✓ **Using Quasi-Zenith Orbit** to cover Japan territory autonomously ;
  - 6 x Quasi-Zenith Satellites
  - 1 x Geostationary Satellite
- ✓ **Full Compatible with GPS-IIF & III** for the benefits of GPS civil users
- ✓ **No military signals intended**, but subject to bilateral agreement between U.S and Japan
- ✓ First launch in 2009
- ✓ Public - Private Partnership : **Navigation & Communications**
- ✓ Initial cost estimated approx. **US\$ 2 Billion**





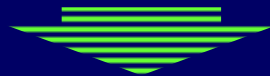
# JRANS Objectives

**Normal Times**  
GPS : available

JRANS  
as a Complementary System

## **Benefits for GPS Civil Users**

1. remove “mask” situation
2. increase SIS availability



**Anomaly Events**

JRANS  
as a Backup System

## **National Security of Japan**

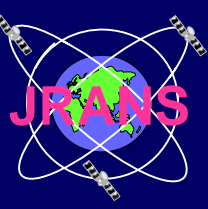
1. Japanese sovereignty
2. minimize impact to existing GPS civil users



**full compliance to**

U.S - Japan GPS Joint Statement in 1998

- ✓ Promote compatibility of operating standards for GPS
- ✓ Encourage trade & investment in GPS equipment & services



# Advantage of Quasi-Zenith Orbit

7

Since FY 1999, NASDA and CRL have been jointly allocating a research fund for “Study of Using Quasi-Zenith Orbit”.

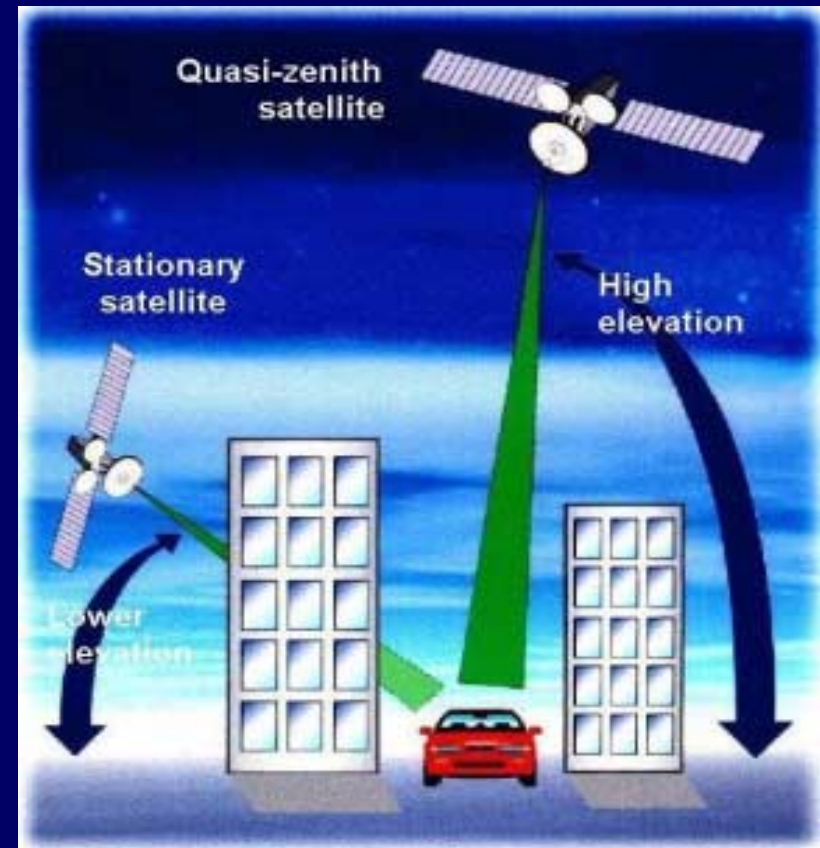
JRANS proposes “dual” - mission concept for PPP scheme:

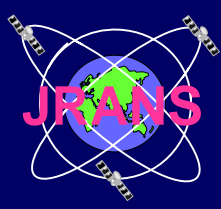
## **NAV : Primary Mission**

- providing SPS signals as a public service
- to be funded by the GOJ

## **COM : Secondary Mission**

- providing a commercial satellite COM service
- to be funded by private sector



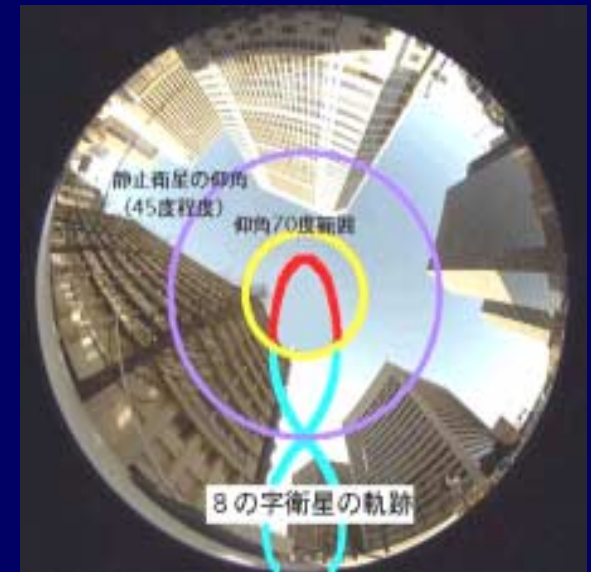
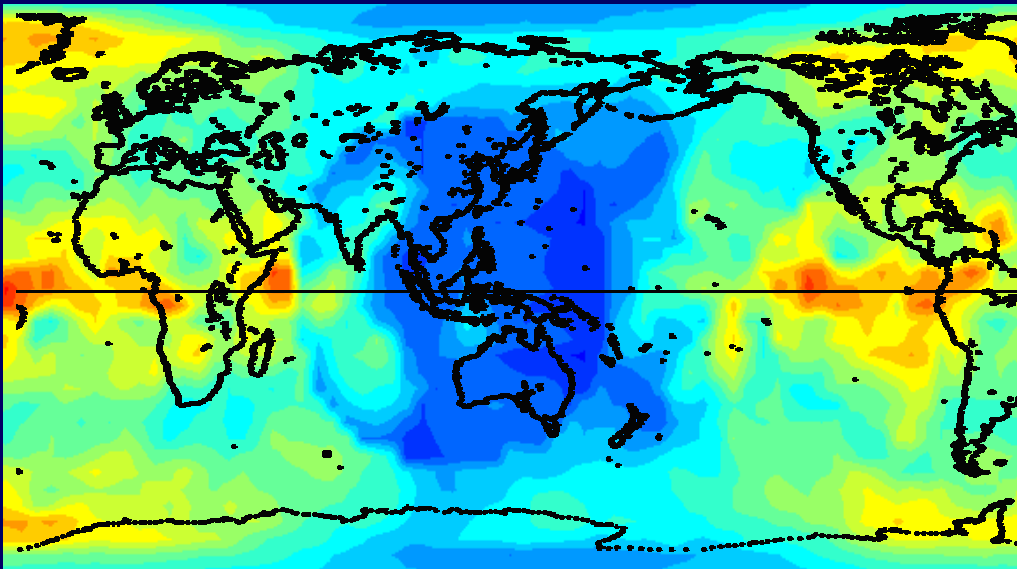


# Use of Quasi-Zenith Orbit

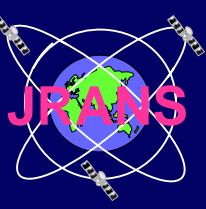
8

**Quasi-Zenith orbit is the best option to operate an independent regional navigation satellite system, where 4 “line-of-sight” satellites could be always seen in the region by means of putting 7 to 8 satellites in the orbit.**

**Using Quasi-Zenith orbit would also have a significant benefits for GPS civil users in mountainous terrain and urban canyons, as they can receive the signal even in higher mask situation.**







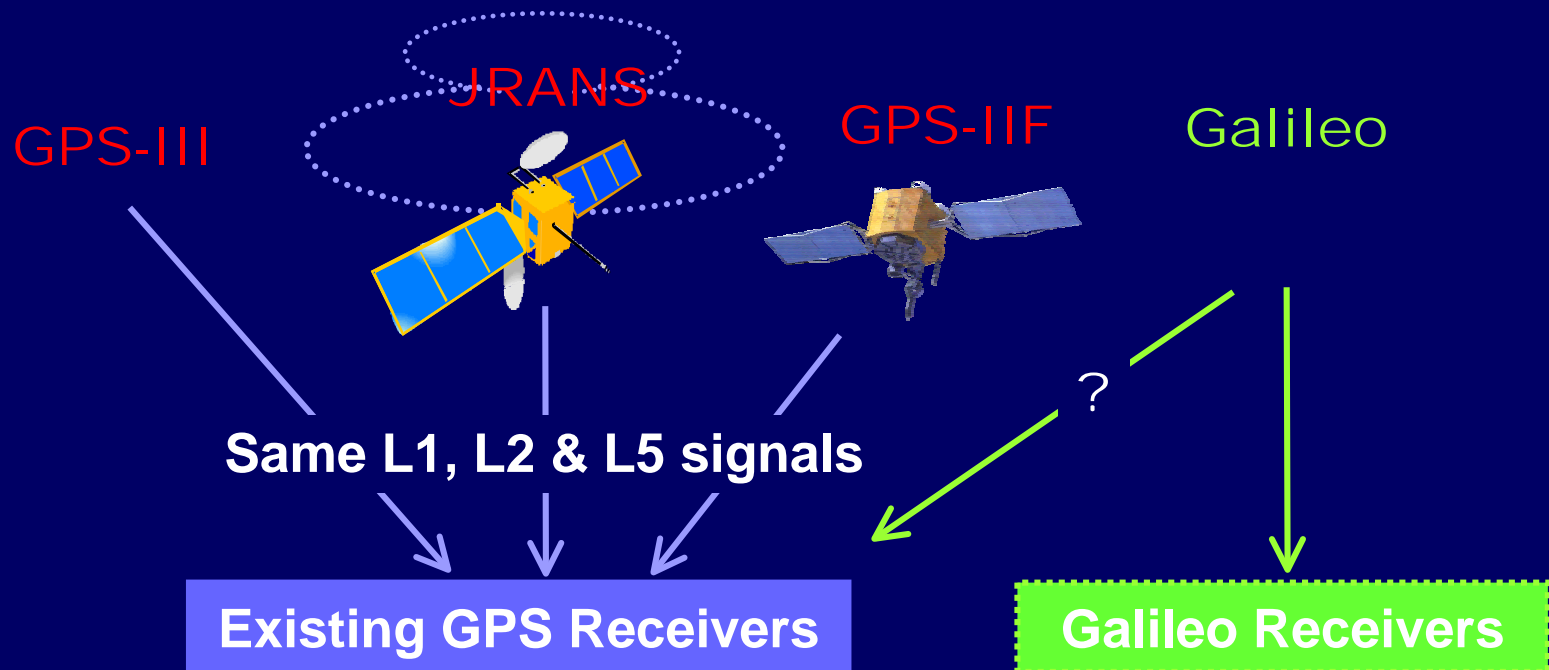
# Compatibility with GPS-IIF/III

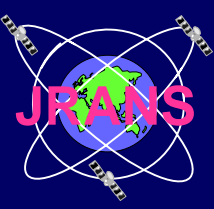
9

## Compliance to the U.S - Japan GPS Joint Statement

Compatibility with GPS is required to achieve the following JRANS objectives ;

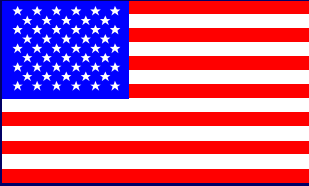
- (1) encourage civil use of GPS by increasing SIS availability
- (2) secure redundancy and regional backup capability for the existing GPS users





# GPS-IIF/III - JRANS R&D Partnership

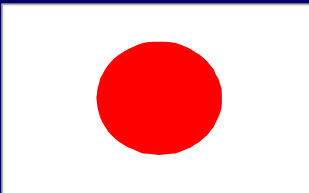
10



**GPS-III development  
- Starting in FY 2004**

## **U.S participation in JRANS program**

- 1. GPS-IIF & III requirement definitions**
- 2. engineering & development supports**
- 3. off-the-shelf technology transfer**
- 4. agreement for Joint Command & Control**



**JRANS development  
- Starting in FY 2004**

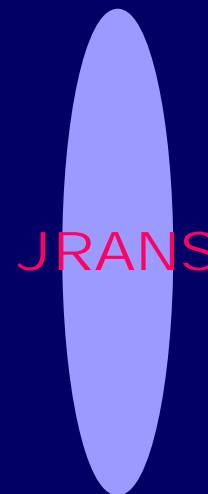
**GPS-IIF / III  
Global System**

**Increase SIS availability  
by regional systems**



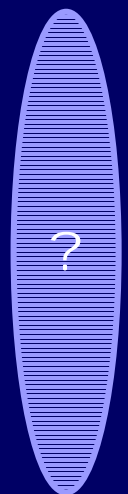
**Region  
# 1**

**Europe**



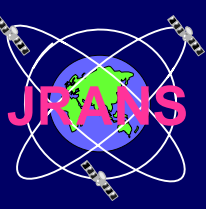
**Region  
# 2**

**Asia-Pacific**

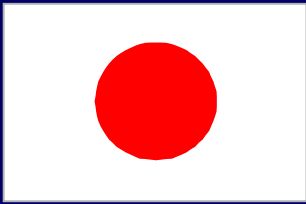


**Region  
# 3**

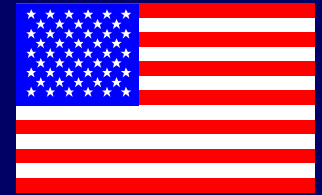
**U.S**



## U.S - Japan Joint Statement



**on Cooperation in the Use of  
Global Positioning System (GPS)  
Standard Positioning Service**



**September 22, 1998**

**Between**

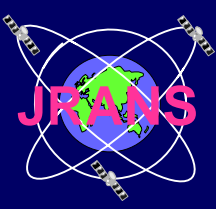
**President William Clinton**

**and**

**Prime Minister Keizou Obuchi**

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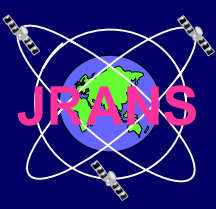
**On February 5, 2001,  
the 1st annual U.S - Japan GPS plenary meeting  
was held in Tokyo to implement ideas  
originally outlined in the Joint Statement.**



Council for  
Science & Technology  
Policy in Cabinet Office  
( CSTP )

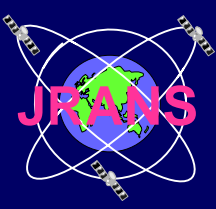
- ✓ The CSTP, established in Jan 2001, plays a role of a “source of wisdom” to support the prime minister and the Cabinet in scientific and technical matters :
  - basic/comprehensive policy planning of science & technology
  - general coordination taking the initiative among the ministries concerned, with an overall and panoramic view
- ✓ The CSTP established “Expert Panel on Space Development & Utilization” in Oct 2001. **The Expert Panel is listing “Navigation” as one of the areas for strategic & important space development & utilization.**
- ✓ The Expert Panel will complete a long-term strategic planning for promotion of space utilization & industrialization in May 2002





Ministry of Land,  
Infrastructure &  
Transport ( MLIT )

- ✓ In Mar 26 meeting of the Expert Panel under CSTP, MLIT announced to form its intra - ministry study group on “Next Generation Navigation Satellite” in FY 2002
- ✓ MLIT’s “Way of Thinking” ;
  - 1) **emphasizes US - Japan partnership under Joint Statement** as a bottom line for future planning
  - 2) before decision to build or not, will conduct initial study focusing on requirements and benefits, as well as identifying bottleneck of current systems and potential demands in the future
  - 3) after decision to build, will conduct further study including ;
    - NAV & COM dual - mission
    - Public - Private Partnership

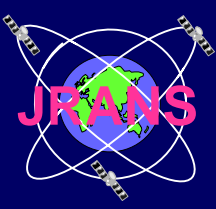


**Ministry of  
Economy, Trade &  
Industry ( METI )**

- ✓ In Oct '01, as per direction of METI, SJAC formed the industrial working group to study “Regional NAV Satellite using Quasi-Zenith Orbit”
- ✓ Objectives of the **SJAC study are to identify benefits for GPS users and to build PPP - based business model**
- ✓ SJAC working group, in association with USEF (a foundation by aerospace industries with full support of METI), will finalize the report to METI by the end of May '02

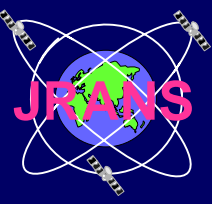
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\* SJAC : Society of Japanese Aerospace Companies  
USEF : Institute for Unmanned Space Experiment Free Flyer



Ministry of Public  
Management, Home  
Affairs, Posts &  
Telecom ( Soumu-Sho )

- ✓ Soumu-Sho and its subsidiary Institute, CRL have studied “Use of Quasi-Zenith Orbit” since FY 1999, principally aiming at research of its funding opportunity in a future experimental satellite program.
- ✓ Soumu-Sho announced its planning, in the Feb 2002 study report for “Future of Space Communications”, to launch **“Experimental NAV & COM Quasi-Zenith Satellite program”** jointly with MEXT ;
  - Funding for Development : starting in around FY 2003
  - Launch of experimental sat : in FY 2007
  - Launch of operational sat : FY 2010 (estimate)



# Your Questions

16

**Which organization within the GOJ will take a lead ?**

**Where the money comes from for \$ 2 billion dollar program ?**

**Are the other countries in Asia-Pacific region expected to participate in funding or operating JRANS ?**

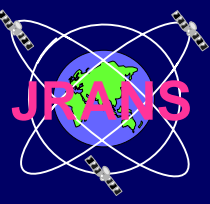
**Council for  
Science & Technology  
Policy in Cabinet Office  
( CSTP )**

**Ministry of Land,  
Infrastructure &  
Transport ( MLIT )**

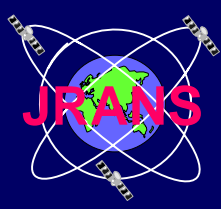
**Ministry of  
Economy, Trade &  
Industry ( METI )**

**Ministry of Public  
Management, Home  
Affairs, Posts &  
Telecom ( Soumu-Sho )**





- ✓ To establish an inter-ministry joint study office in the Cabinet office, to make a concentrated study of JRANS - like system ;
  1. definition study for requirements & user benefits
  2. assessment on indigenous development capability
  3. bilateral discussion in the U.S - Japan GPS plenary meeting
  4. extended study of PFI approach
- ✓ To facilitate a new budget category like “Space Utilization” extended from IT - related new “public work”, rather than using the limited budget for “Space Development”
- ✓ To make a timely decision to build or not . . . . by end FY 2003, in order to effectively synchronize with GPS-IIF & III program, and to provide better SIS availability for GPS industries and users before Galileo launches



## **Part 2**

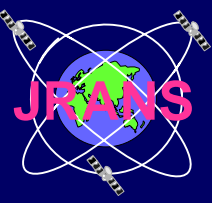
### **Technical Session for JRANS Presentation**

**Kazuhide TODOME, VP & Deputy General Manager  
Project Operation Division**

**and**

**Takeshi ONO, Senior Manager  
System Development Division**

**NEC TOSHIBA Space Systems, Ltd.**

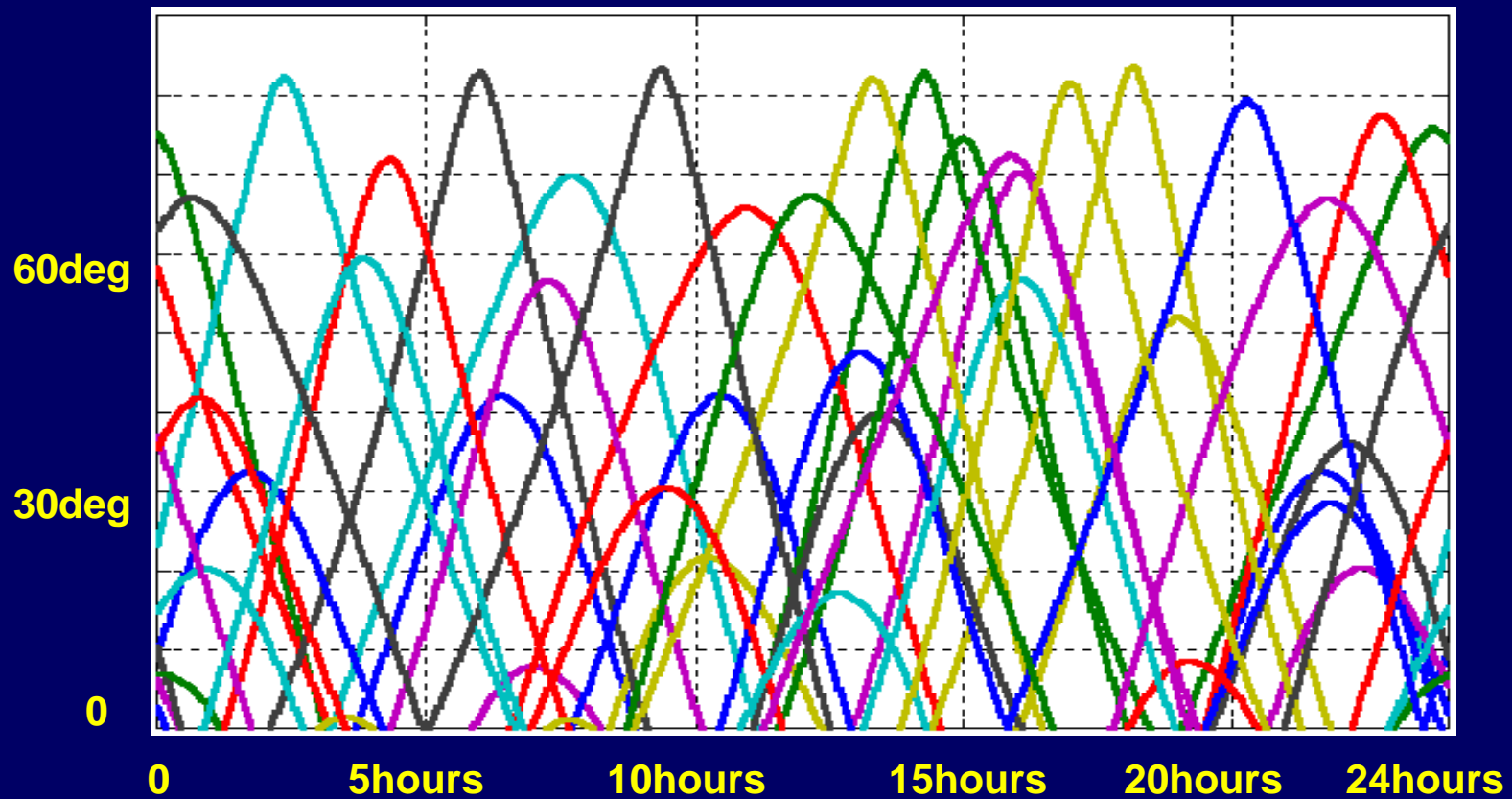


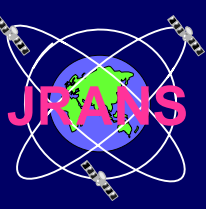
# GPS Visibility and JRANS

19

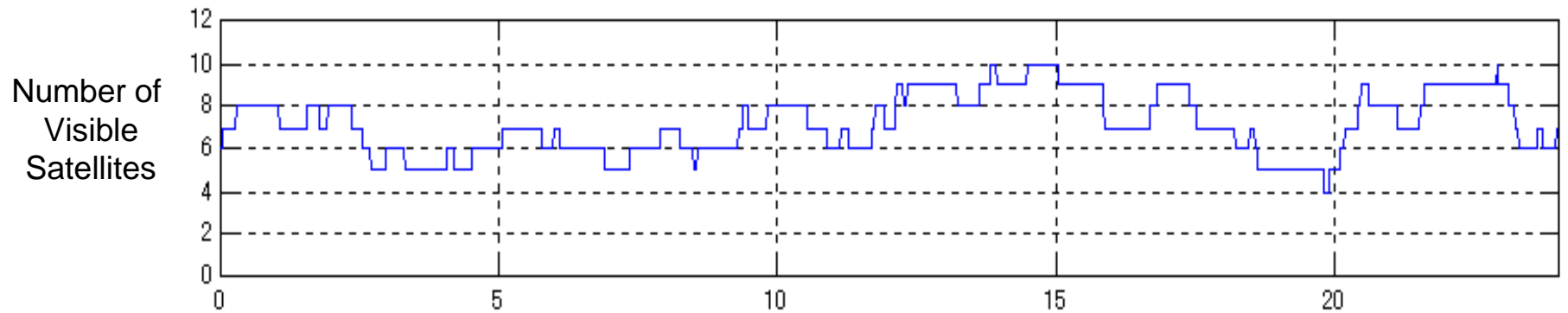
**GPS visibility depends on time and elevation mask angle.  
Not all GPS users satisfy the required performance.  
JRANS will improve the performance of the high EL mask users.**

## **GPS Elevation @ TOKYO**

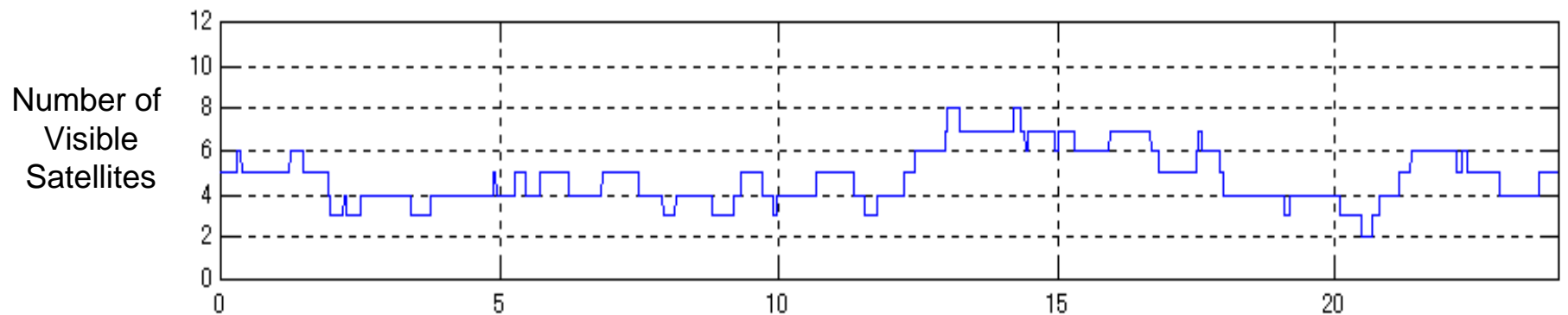




# GPS Visibility vs. User Elevation Mask Angle<sup>20</sup>

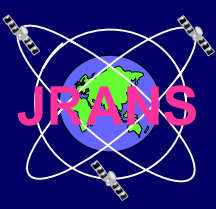


**X-axis:Time (hours)**  
**Elevation Mask 15deg**

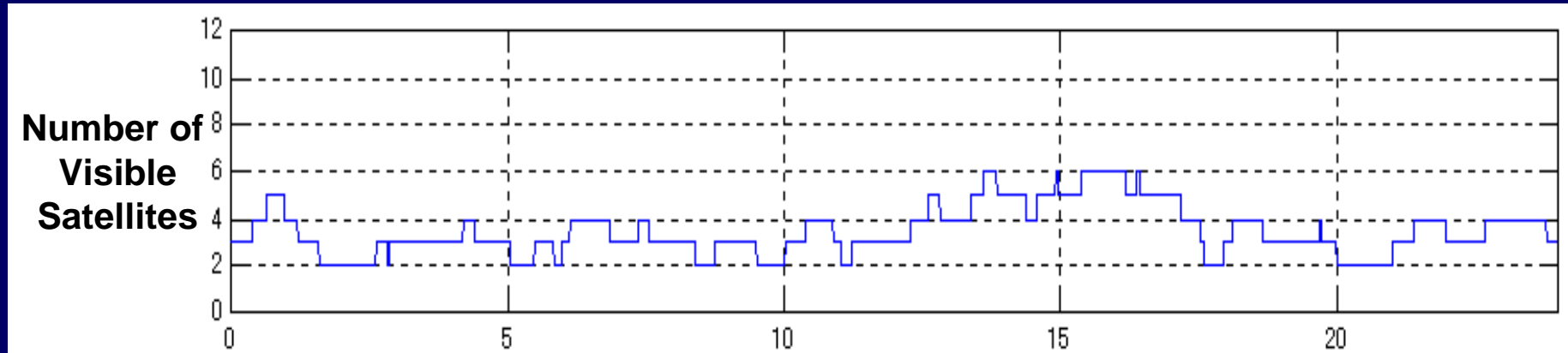


**X-axis:Time (hours)**  
**Elevation Mask 30deg**



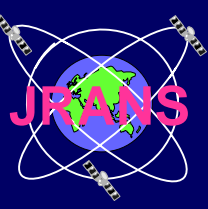


# GPS Visibility vs. User Elevation Mask Angle <sup>21</sup>

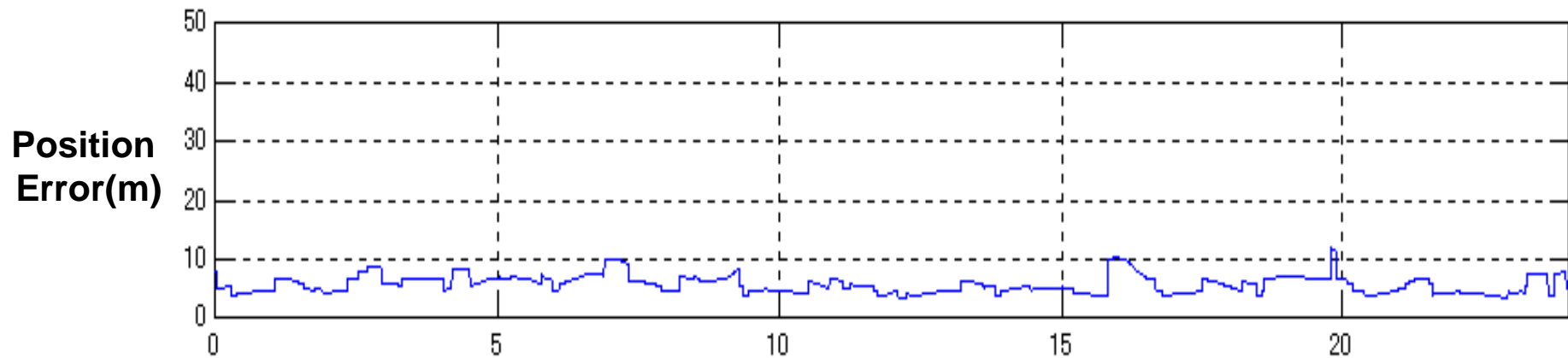


**X-axis:Time (hours)**  
**Elevation Mask 40deg**

**GPS user of high elevation mask angle  
needs additional satellites.**

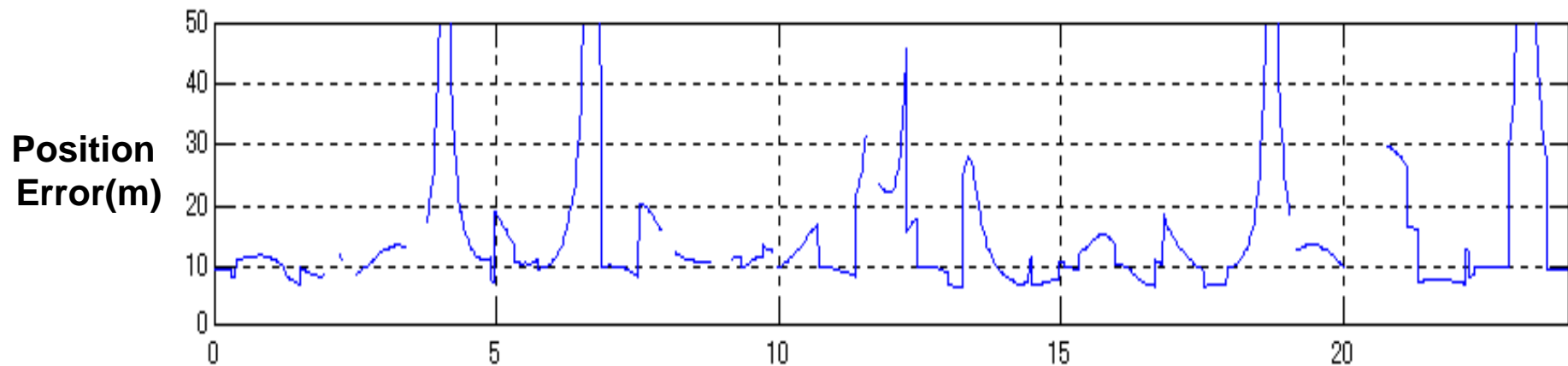


# Position Error v.s. User Elevation Mask Angle<sup>22</sup>



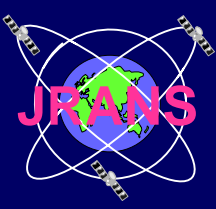
**X-axis:Time (hours)**

**Elevation Mask 15deg Tokyo URE 2m**

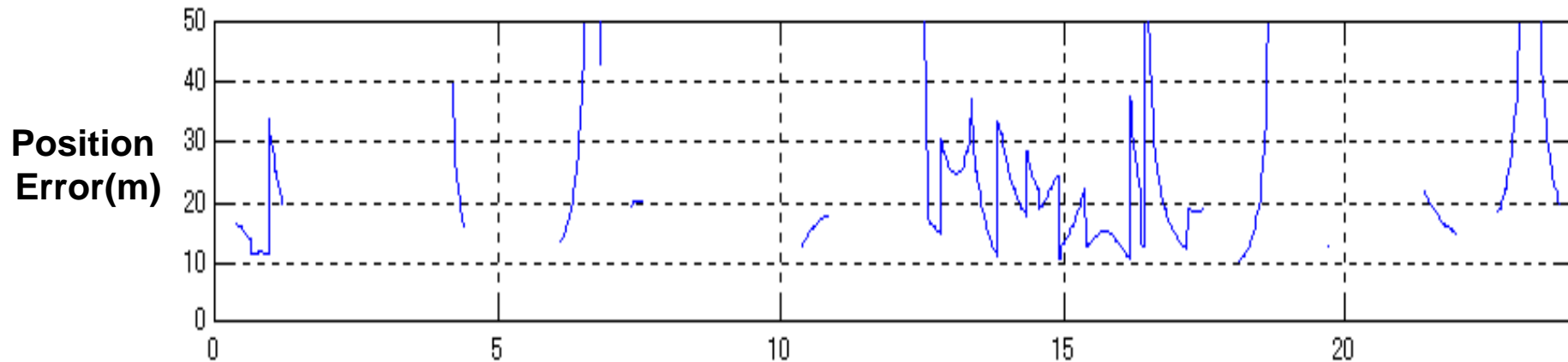


**X-axis:Time (hours)**

**Elevation Mask 30deg Tokyo URE 2m**



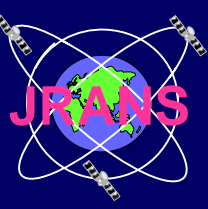
# Position Error v.s. User Elevation Mask Angle<sup>23</sup>



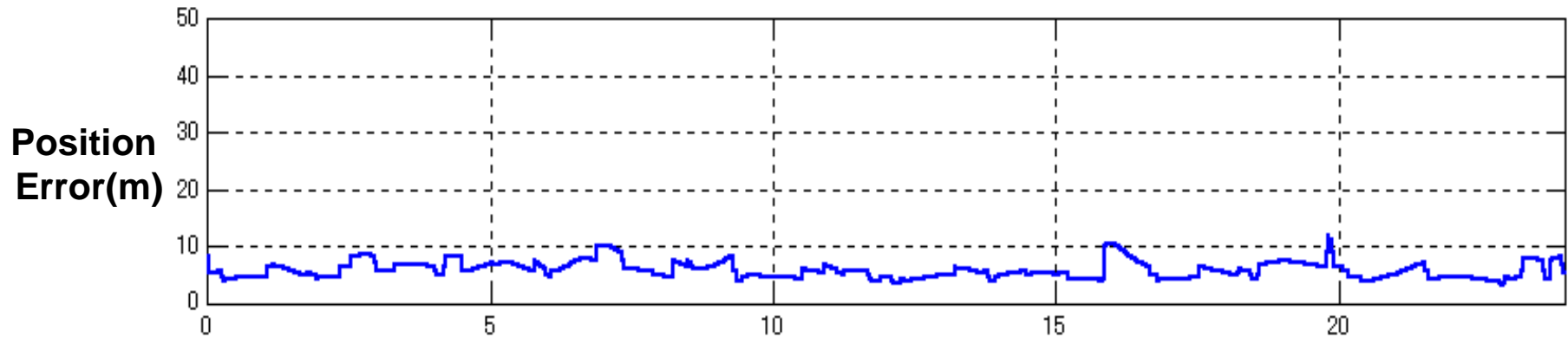
**X-axis:Time (hours)**

**Elevation Mask 40deg Tokyo URE**

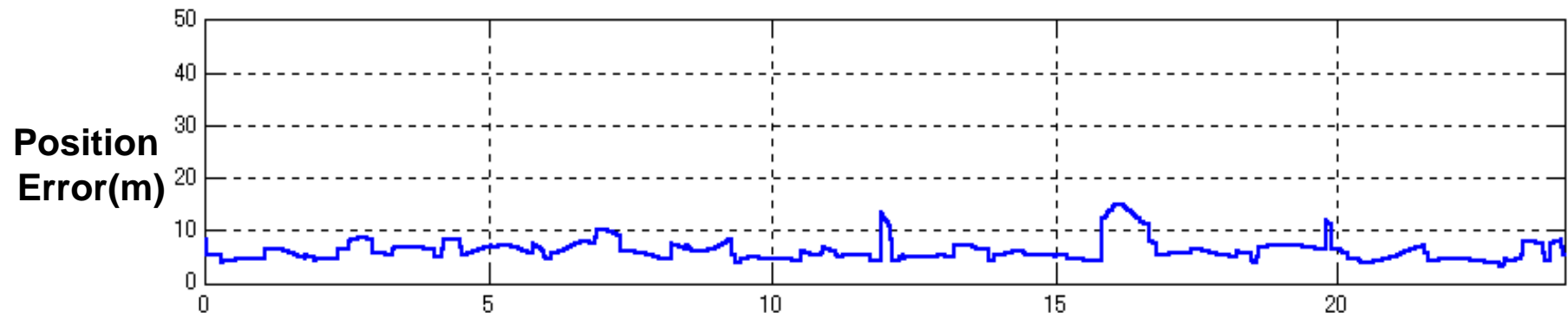
**GPS users of high elevation mask angle  
needs additional satellites  
to improve the positioning availability.**



# Degradation of Accuracy with 1 or 2 GPS Outage <sup>24</sup>

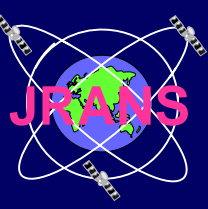


Elevation Mask 15deg with No GPS Outage X-axis:Time (hours)

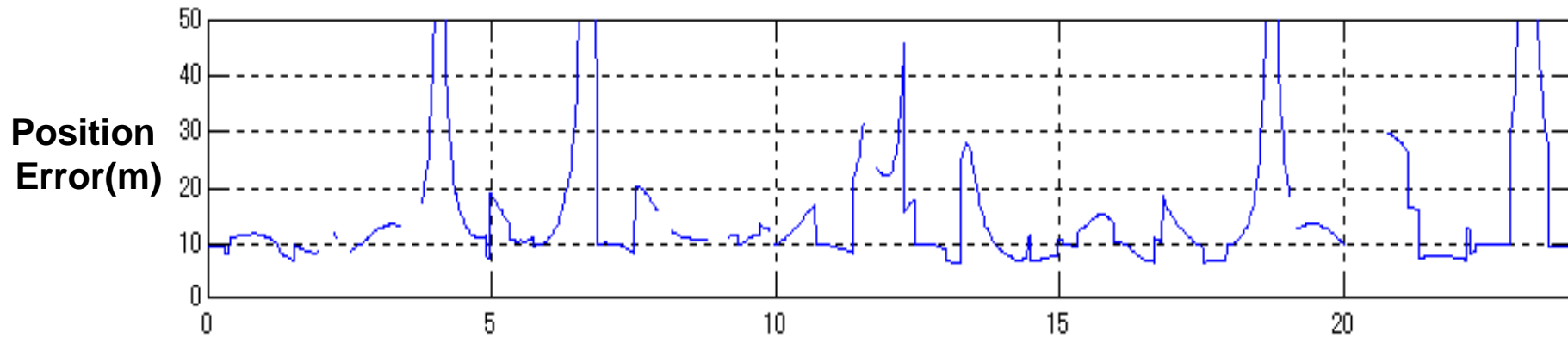


PRN9 outage

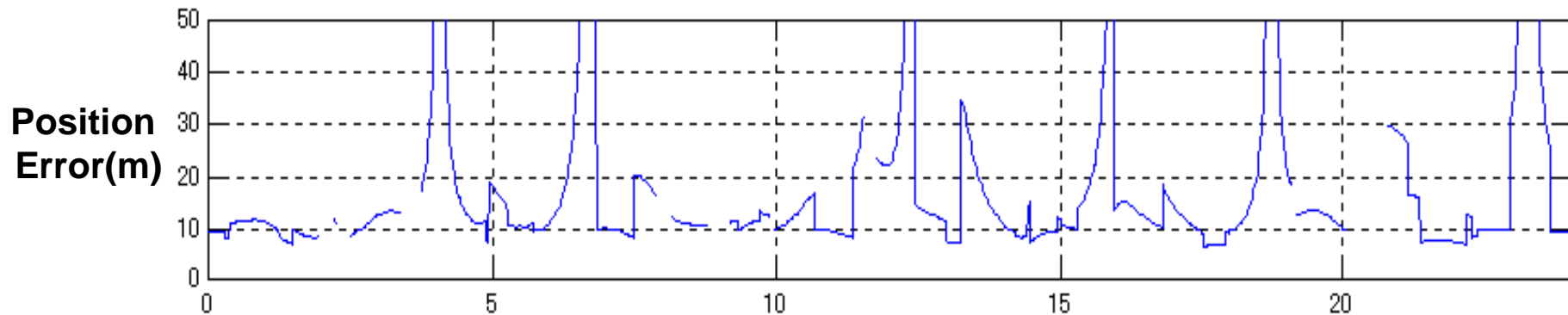
Elevation Mask 15deg with one GPS Outage X-axis:Time (hours)



# Degradation of Accuracy with 1 or 2 GPS Outage <sup>25</sup>

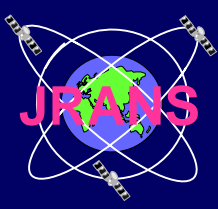


Elevation Mask 30deg with No GPS Outage X-axis:Time (hours)

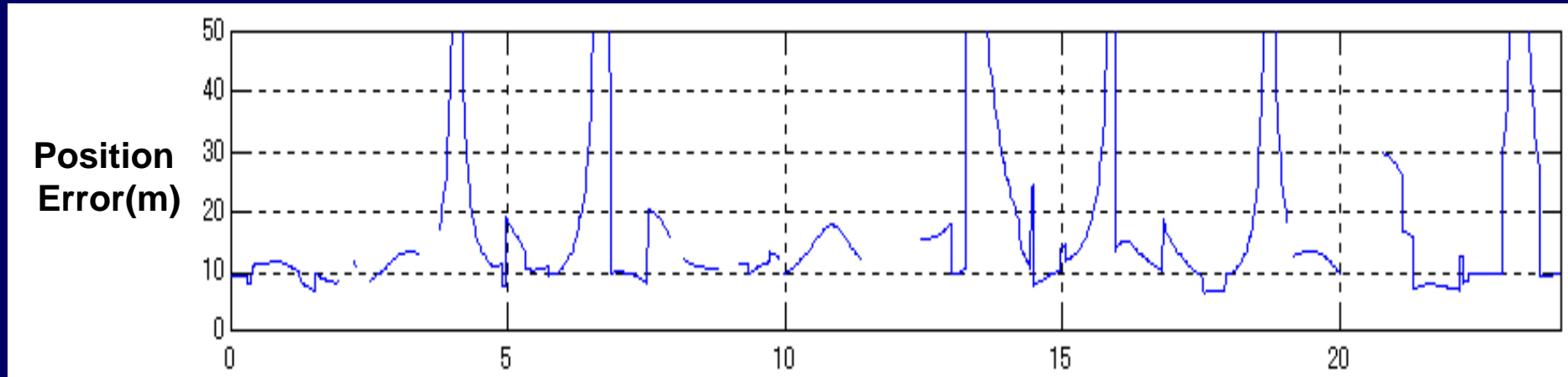


PRN 9 outage

Elevation Mask 30deg with one GPS Outage X-axis:Time (hours)



# Degradation of Accuracy with 1 or 2 GPS Outage <sup>26</sup>

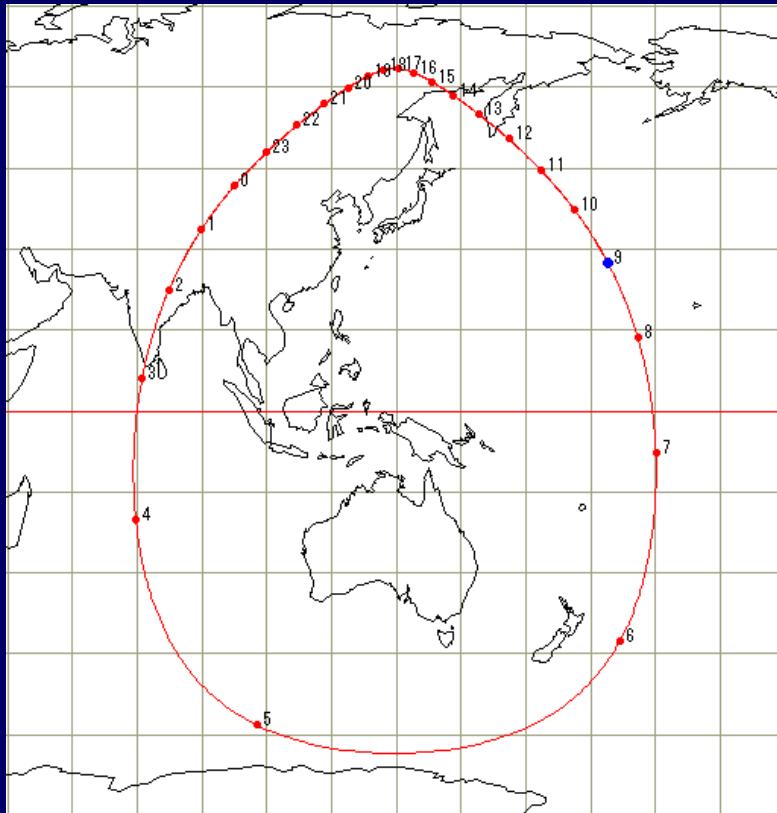
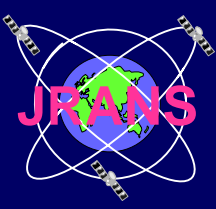


**X-axis:Time (hours)**

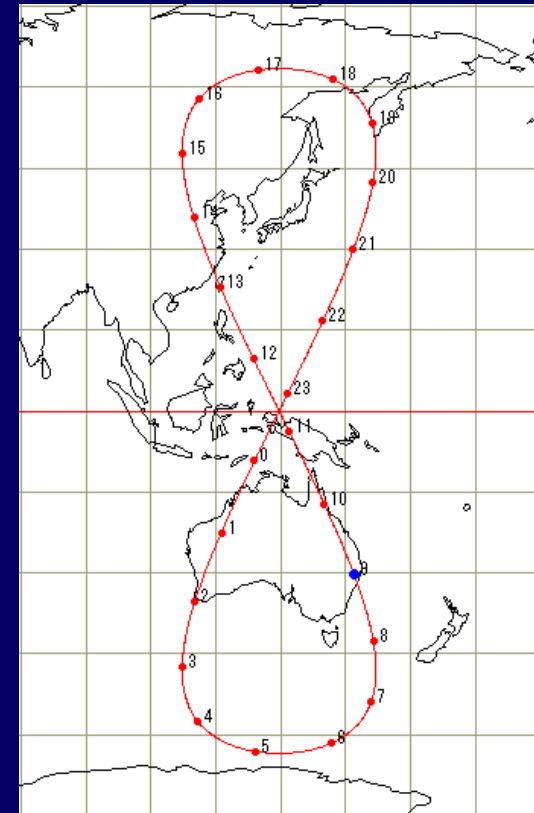
PRN 9 outage

PRN 23 outage

Elevation Mask 30deg with two satellites Outage



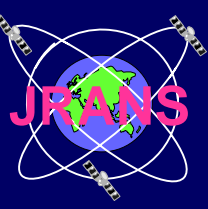
60000km x 19000km Orbit( $e=0.55$ )



8-figure IGSO( $e=0$ )

**Orbit parameters should be optimized to maximize the performance. Highly elliptical orbit will increase the availability of JRANS in northern hemisphere**

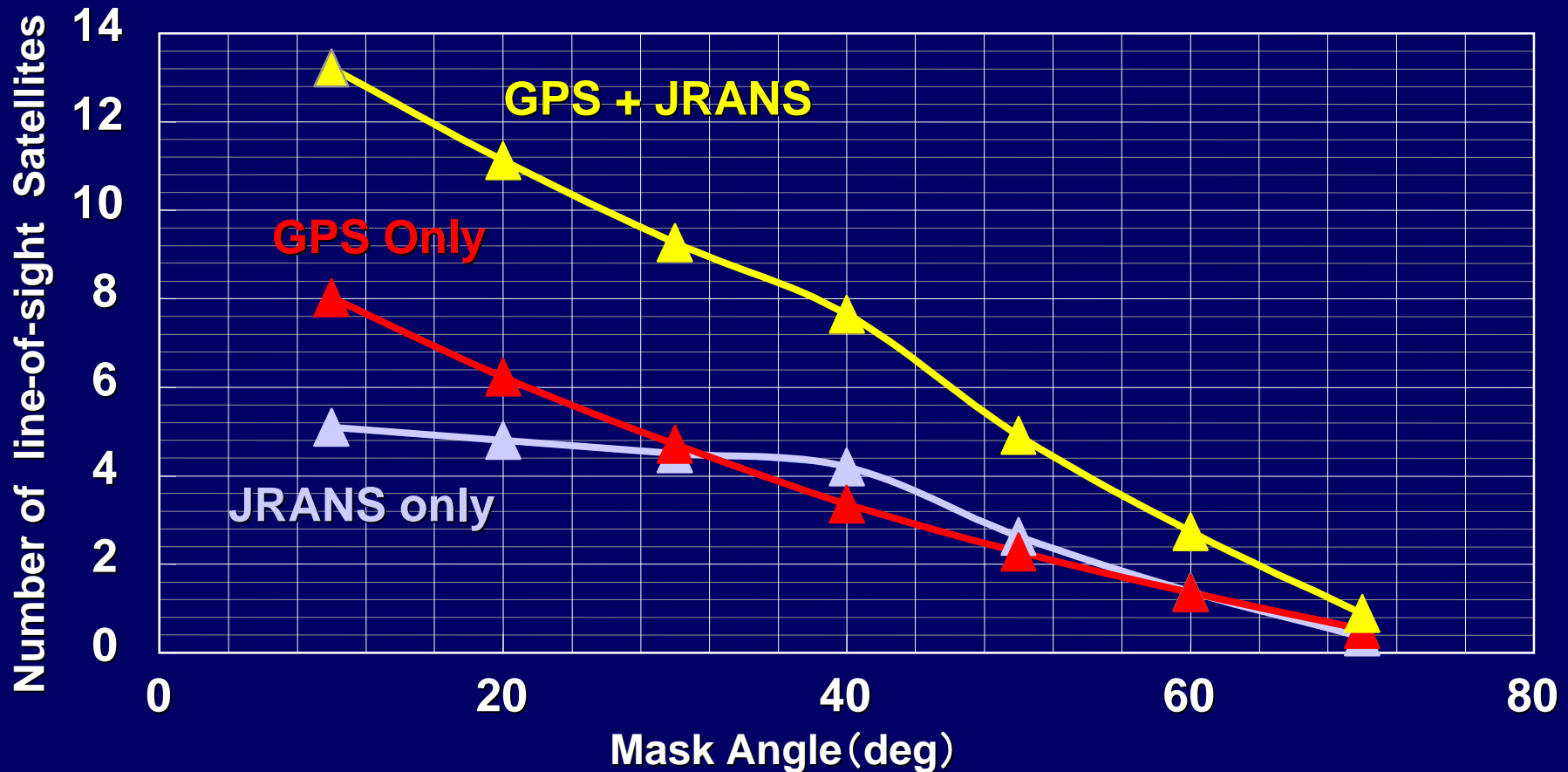




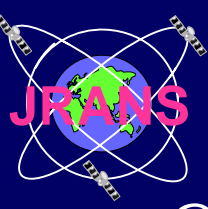
# Advantage of Quasi-Zenith Orbit

28

Simulation of GPS + JRANS Advantage :



**In the case of GPS + JRANS, more than 8 satellites can be seen in over 30 degree mask angle situation**

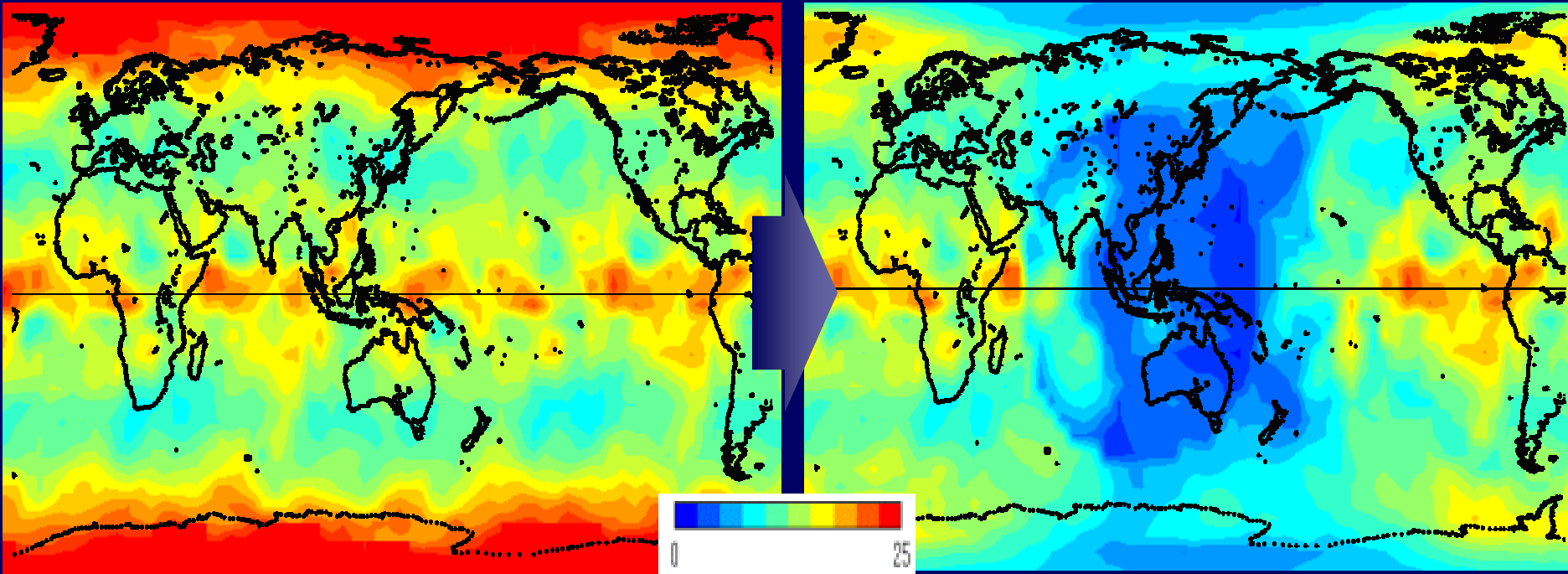


# Improvement of GDOP by JRANS

29

GDOP : GPS only

GDOP : GPS + JRANS

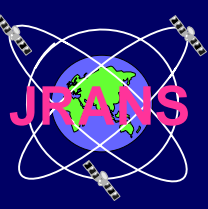


EL Mask	10deg	30deg
GDOP (@Tokyo)	2.5	7.0

30degree elevation mask is typical for Japanese urban area.

EL Mask	10deg	30deg
GDOP (@Tokyo)	2.5	4.0

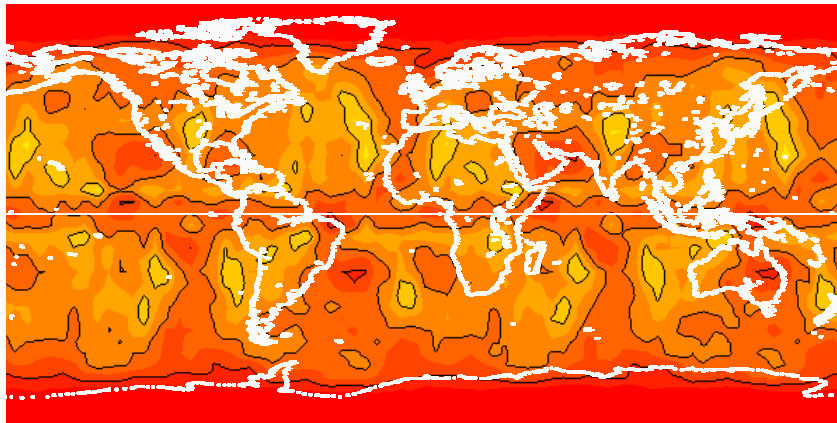
JRANS will augment GPS for high elevation users.



# Improvement of Availability by JRANS <sup>30</sup>

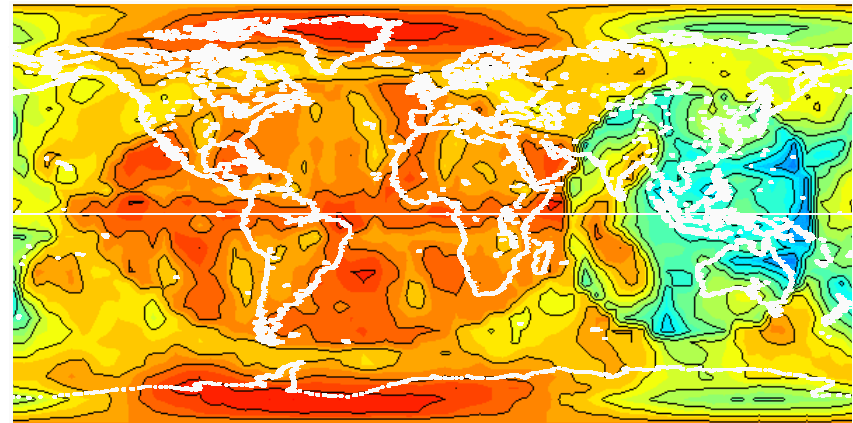
Availability in 24 hours (GDOP < 5)  
Elevation Mask = 30deg

GPS only

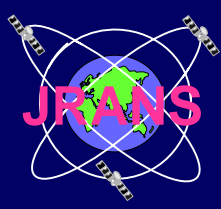


GPS + JRANS

(IGSO × 6 + GEO × 1)



**Improvement of availability by JRANS  
is obvious for high elevation mask users.**



**GPS visibility and user accuracy are degraded in urban area due to the limitation of high elevation mask.**

**Regional augmentation in space by GEO + IGSO will improve accuracy, availability and continuity of navigation.**

**Optimization of JRANS constellation will be conducted based on the future study of performance specification such as coverage, accuracy, availability, continuity and integrity and compatibility with GPS.**